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Original Report

A study on the analysis of heart rate variability among women with gestational diabetes mellitus

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Abstract:

Objective: To analyze heart rate variability (HRV) among women with gestational diabetes mellitus.

Methods: A total of 60 women of >20 weeks gestational age were included (30 cases and 30 controls). All the subjects of the study were undergone an oral glucose tolerance tests (oGTT) generating diagnostic indicators for gestational diabetes mellitus (GDM). The recording of short term HRV was done according to the recommendation of the task force on HRV. Following 10 minutes of supine rest in autonomic laboratory of department of physiology, all leads of HRV was placed over the subject in requisite position. Lead II of ECG was recorded during supine rest using Medicaid 4 channel system.

Results: There was no significant (p>0.05) difference in age, height, weight and BMI between cases and controls showing the comparability of the groups. Both systolic and diastolic blood pressure was found to be significantly (p=0.0001) higher among cases compared to controls. Peak frequency (in Hz) and peak power (%) were found to be significantly (p=0.0001) higher among cases compared to controls.

Conclusion: results of study demonstrate that there was significant higher HRV in the patients with GDM than controls.

Key words: Gestational diabetes mellitus, Heart rate, Systolic blood pressure, Diastolic blood pressure.

INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as carbohydrate intolerance of varying degrees of severity with onset or first recognition during pregnancy (Metzger and Coustan 1998). The incidence of GDM occurs in about 3-5% of all pregnancies and it is often associated with maternal risk factors such as overweight, advanced age, positive family history of type-2 diabetes mellitus and a previously complicated obstetric history. GDM is also associated with a high risk of subsequent development of maternal diabetes later in life and cardiovascular disease (Bellamy et al, 2009; Sullivan et al, 2012).

As a result of recent advances, the use of heart rate variability (HRV), or beat-to-beat fluctuations in heart rate (HR), is expanding outside of cardiology into other fields, such as rehabilitation medicine and obstetrics (Picard et al, 2009). Evidence is growing to support the use of HRV in determining health or disease and overall competence of the autonomic nervous system (Allen et al, 2007).

HRV is a low-cost, noninvasive clinical measure that is effective in distinguishing between healthy physiology and pathophysiology and determining autonomic maturation. For example, fetuses compromised by nicotine during development have low HR and lower HRV than do non-exposed fetuses of the same age which is indicative of decreased autonomic maturation (Linda et al, 2016).

In the recent years, spectral analysis of Heart Rate Variability (HRV) has been enormously used as a diagnostic tool to assess autonomic functions in different clinical disorders. This also provides a sensitive and early indicator of health impairments (Khan et al, 2014).

The objective this study was to analyze heart rate variability among women with gestational diabetes mellitus.

MATERIAL AND METHODS

After obtaining the approval from the Institutional Ethical Committee, a total of 60 women of >20 weeks gestational age were included (30 cases and 30 controls). The informed consent was all from all the pregnant women before enrolling in the study. All the subjects were explained about the purpose of the study.

All the subjects of the study were undergone an oral glucose tolerance tests (oGTT) generating diagnostic indicators for GDM according to the International Association of Diabetes and Pregnancy Study Groups (IADPSG Consensus Panel, 2010) criteria. GDM was diagnosed in the 24-28th week of gestation using oGTT with 75 g glucose load, when fasting glucose in venous plasma was less than 7.0 mmol/l. Women, whose fasting glucose was 7.0 mmol/l and more, did not have to go through the functional test as they were diagnosed by the fasting glucose level as overt diabetes in pregnancy. Plasma glucose samples were collected at fasting, as well as one and two hours after glucose load. The diagnosis of gestational diabetes was established if any of the test values was abnormal: if fasting plasma glucose exceeded 5.5 mmol/l, one hour plasma glucose exceeded 8.8 mmol/l or two hours oGTT plasma glucose exceeded 7.7 mmol/l

Subjects of control group included pregnant women who had any risk factors for GDM. All the subjects were examined and detailed personal history was taken. Physical examination was done and anthropometric measurement like height & weight were taken. BMI was calculated as per Quetlet's index.

The recording of short term HRV was done according to the recommendation of the task force on HRV. Following 10 minutes of supine rest in autonomic laboratory of department of physiology, all leads of HRV was placed over the subject in requisite position. Lead II of ECG was recorded during supine rest using Medicaid 4 channel system. The data was transferred from Medicaid machine to window based computer with HRV analysis software.

Statistical analysis

The results are presented in mean±SD. Unpaired t-test was used for comparisons. The p-value<0.05 was considered significant. All the analysis was carried out on SPSS 16.0 version (Chicago, Inc., USA).

RESULTS

There was no significant (p>0.05) difference in age, height, weight and BMI between cases and controls showing the comparability of the groups (Table-1).

Table-1: Distribution of basic profile of cases and controls

Basic profile	Cases (n=30)	Controls (n=30)	p-value[1]
Age in years	27.12±3.10	27.90±4.23	0.41
Height	156.11±4.12	155.14±3.25	0.31
Weight	57.26±9.56	58.21±10.25	0.71
BMI	23.86±2.36	24.18±3.21	0.66

[1]Unpaired t-test

Both systolic and diastolic blood pressure was found to be significantly (p=0.0001) higher among cases compared to controls (Table-2).

Table-2: Comparison of blood pressure between cases and controls

Blood pressure (mmHG)	Cases (n=30)	Controls (n=30)	p-value[1]
Systolic blood pressure	133.13±11.30	117.13±12.40	0.0001*
Diastolic blood pressure	86.28±12.31	78.26±10.29	0.0001*

[1]Unpaired t-test, *Significant

Table-3 & 4 shows the comparison of peak frequency and peak power between cases and controls. Peak frequency (in Hz) and peak power (%) were found to be significantly (p=0.0001) higher among cases compared to controls.

Table-3: Comparison of peak frequency between cases and controls

Peak frequency in Hz	Cases (n=30)	Controls (n=30)	p-value[1]
Very low	0.039±0.007	0.021±0.002	0.0001*
Low	0.095±0.09	0.075±0.08	0.0001*
High	0.136±0.021	0.182±0.041	0.0001*

[1]Unpaired t-test, *Significant

Table-4: Comparison of peak power between cases and controls

Peak power (%)	Cases (n=30)	Controls (n=30)	p-value[1]
Very low	32.12±21.23	22.26±17.21	0.0001*
Low	63.19±5.26	51.10±8.26	0.0001*
High	23.15±5.26	16.25±6.25	0.0001*

[1]Unpaired t-test, *Significant

DISCUSSION

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy (Metzger and Coustan 1998). GDM is associated with increased cardiovascular risk later in mother's life (Carpenter, 2007). In the various recent studies, the pathological changes in 24 h blood pressure profile, echocardiography evaluation and heart rate variability were reported in women with GDM (Poyhonen-Alho et al, 2010, Soydinc et al, 2013). However, the intensity of glycemic control during the pregnancy was not sufficiently described there. Hence, the importance of optimal GDM compensation was not evaluated in those studies. It is possible that adequate compensation might have a major effect on the presence of the identified changes.

In this study, there was no significant difference in the anthropometric parameters between GDM and controls. In this context, few studies suggested that the higher BMI has contribution in autonomic imbalance as increased BMI has been reported to increase sympathetic activity (Straznicky et al, 2010). The increase in body weight and BMI in pregnancy is mainly due to increase in size of growing fetus, uterus and placenta and increase in ECF volume, not due to increased adiposity (Cunningham et al, 2005). Therefore, in in study, overall contribution of anthropometric parameters to the blood pressure changes in pregnancy is negligible as the co-relation between the two groups was not significant. The blood pressure measurement in this study observed that study group have higher systolic and diastolic blood pressure than control women.

In this study, compared with mothers with normal glucose regulation (controls), mothers with GDM showed increased heart rate with significant differences of maternal HRV. This is similar to the study by Fehlert et al (2017) but their differences in HRV were not statistically significant. In the present study, Peak frequency (in Hz) and peak power (%) were found to be significantly (p=0.0001) higher among cases compared to controls. In a study (Raelene et al, 2014), comparing ANS measures for GDM+ versus GDM− women during pregnancy and postpartum revealed no significant differences. Time related changes indicated that during late pregnancy total spectral power, low frequency (LF) power, high frequency (HF) power, and RR-variation during deep breathing were significantly reduced ($p < 0.001$ for all). The LF/HF ratio, however, was not significantly affected during late pregnancy ($p = 0.678$).

Diagnostic and screening criteria for gestational diabetes mellitus are still not internationally unified. Recently, the International Association of Diabetes and Pregnancy Study Groups (IADPSG Consensus Panel, 2010) recommended new screening criteria for GDM based on the HAPO study results. The new criteria have been accepted in the Czech Republic this year. The objective of the HAPO study was to clarify associations of levels of maternal glucose lower than those diagnostic of diabetes with perinatal outcome (The HAPO Study Cooperative Research Group 2008).

In summary, results of study demonstrate that there was significant higher HRV in the patients with GDM than controls.

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